Bare Mitigation Site
Unnamed Tributary to Peak Creek, Ashe County

Monitoring Report

Prepared for the

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
STREAM MITIGATION PROGRAM

Transportation Improvement Project R 529 BA, BB, BD

Period covered October 22, 2002 to July 7, 2004

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Division of Inland Fisheries
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This monitoring report is submitted as partial fulfillment of the off-site stream mitigation agreement between the North Carolina Department of Transportation (NCDOT) and North Carolina Wildlife Resources Commission (NCWRC) for the R-529 US 421 road improvement project in Watauga County. Under this agreement, a total of 14,814 linear feet of stream mitigation is required by the United States Army Corps of Engineers (USACE) and 7,407 linear feet of mitigation is required by the North Carolina Division of Water Quality (NCDWQ). Mickey and Scott (2002) described survey methods, site conditions, and project objectives in the as-built report. The purpose of this report is to summarize the monitoring data collected in 2002 and 2004 from 2183 linear feet of an unnamed tributary to Peak Creek located on the Bare property, Ashe County (Figure 1). Monitoring data is compared with data submitted in the 2002 as-built report (Mickey and Scott 2002).

Monitoring

The purpose of the Bare mitigation project is to improve in-stream habitat and reduce bank erosion from a previously channelized stream. Since construction was completed in 2001 the stream has remained a C/b4 stream type (Rosgen 1996). The as-built survey was completed on November 8, 2001, the first and second year monitoring surveys were completed on October 22, 2002 and on May 4, 2004. These surveys included longitudinal profiles, channel cross-sections, pebble counts, stem counts (planted trees/live stakes), and a photo log of the site (Appendix 1). Bankfull rain events were monitored through review of the United States Geological Survey's South Fork New River gage (03161000) near Jefferson, North Carolina, by photos (Appendix 1) and by personal observations of bankfull stage stakes placed on site. Since completion of the as-built survey (Mickey and Scott 2002) there have been seven bankfull or greater than bankfull events at the site (Table 1). It should be noted that the fall of 2002 through 2003 was an unusually wet period. Of the seven bankfull events that occurred during this time the storm on November 19, 2003 was the most severe. This storm dropped 6 inches of rain in less than 8 hours on the site (personal communication, landowner). This storm caused a new head cut channel to be created across a point bar at station 2+90 (Figure 3.2) and damaged the cattle crossing gates (Appendix 1). These damaged areas were repaired in 2004.

Longitudinal Profile Monitoring

Since construction was completed in September 2001, several channel adjustments have occurred to the longitudinal profile (Figure 2). The 2002 monitoring survey shows that the stream bottom aggraded along a series of small rock vanes from stations 0+17 to 0+89, filling in the small constructed pools (Figure 2.1). In 2004 this section degraded slightly towards post-construction elevations, however, the pools were not reestablished. The aggrading that took place in the constructed pools in this section was not unexpected. The rock vanes constructed in this area were an experiment to see if pools could be created along this reach utilizing riprap placed on the streambank by the landowner years ago. Apparently, the stream grade through this area was too low and the bed load settled out in the constructed pools.

As a result of the November 19, 2003 storm event, a major change occurred in the longitudinal profile from stations 1+12 to 2+33 (Figure 2.1). During this storm event, bed load materials began to deposit in the channel at station 2+33, causing a side channel to develop across a point bar upstream at station 2+18. As this new bar channel deepened, stream velocities were reduced in the main channel and additional streambed materials began to be deposited in the main channel from stations 2+33 to3+30 (Figure 2.1). At station 3+30 the new bar channel connected with the main channel. From station 3+30 to the end of the project some minor differences between the 2002 and 2004 longitudinal surveys can be noted (Figures 2.1, 2.2 and 2.3). At station 18+75 a new, deep pool was formed and from stations 19+54 to 20+26 an existing pool was filled in by streambed materials. These changes are a direct result of the November 19, 2003 flood (Appendix 1). Repair work was completed on July 7, 2004 from station 2+33 to 3+30 to reshape the point bar and eliminate the newly formed bar channel.

Cross-section Monitoring

Nine cross-sections were established during the post-construction survey and re-surveyed during 2002 and 2004. Two additional cross-sections were added in 2004, one to monitor a potential problem area and the other to monitor a stable pool maintained by root wads.

CROSS-SECTION 1+78 - pool (Figure 3.1): This cross-section is located over a long pool. There have been some changes in this cross-section profile from 2001 to 2002 as a result of the November 19, 2003 flood. The left bank has increased in height approximately 1.4 feet near the waters edge. This is a direct result of the flood depositing bed materials along this area. The center thalwag has been eliminated due to a 0.37 ft rise of the mid-section of the stream channel, causing a shift in the thalwag to the left and right banks. These changes have not caused channel instability as the banks exhibit stable elevations and breaks in slope.

CROSS-SECTION 2+90 – pool (Figure 3.2): This cross-section is located over a meander pool stabilized by root wads. The left and right banks have remained stable but some major changes have occurred across the wide point bar. The November 19, 2003 flood created a 15 ft wide head cut and resulting channel across the bar from stations 0+33 to 0+48. This head cut channel does not extend all the way across the bar, but the potential exists for it to do so over time. If this occurs the meander and pool at this location would be eliminated. Deposition from the November 19, 2003 flood increased the height of the bar 0.87 ft from stations 0+48 to 0+67.7 and filled in the pool at the base of the root wads 1.07 ft. This area was repaired on July 7, 2004 by reshaping the point bar to eliminate the new channel.

CROSS-SECTION 6+29 – pool (Figure 3.3): This is a new cross-section located over a pool on a section of eroding bank that developed after the November 19, 2003 flood. The bank had never been a problem until this flood event. This cross-section was established to monitor the eroding bank and to monitor repairs to the bank that were completed on July 7, 2004.

CROSS-SECTION 7+19 – pool (Figure 3.4): This cross-section is located over a pool stabilized by root wads. The post-construction and 2002 monitoring cross-section surveys indicated no major changes in this cross-section. The 2004 survey shows a deepening of the pool by 1.17 ft and some deposition on the point bar, a result of the November 19, 2003 flood. Both banks exhibit the same elevations and breaks in slope from previous surveys.

CROSS-SECTION 10+35 – riffle (Figure 3.5): This cross-section is located over a stable riffle immediately upstream of the second livestock crossing at longitudinal profile station 10+64. This was a wide, shallow riffle area and the purpose of this cross-section was to monitor the natural changes in the channel once livestock were excluded from the riparian zone. The width of the wetted perimeter indicates how much this channel has narrowed from 2001 to 2004. The wetted perimeter decreased from 18.3 ft in 2001, to 13 ft in 2002, and to 9.2 ft in 2004. The left bank has slowly widened creating a sloping bank, effectively narrowing the channel while the right bank has remained stable. As the vegetation along the slope of the left bank has become established, it has trapped materials suspended during bankfull events, effectively rebuilding the left bank with a stable slope. A wet spring seep is located from cross-section station 0+72 to 0+75.

CROSS-SECTION 11+68 – riffle (Figure 3.6): This cross-section is located over a riffle which has a high left bank and long, sloping point bar on the right bank. There has been a noticeable change in the maximum height of the point bar, an increase of 0.78 ft from the post-construction survey. This is attributed to vegetation trapping stream bed materials during flood events. Since completion of the stream work at this cross-section, the thalwag has aggraded by 0.45 ft. Both banks exhibit the same elevation and breaks in slope.

CROSS-SECTION 16+81 – riffle (Figure 3.7): This cross-section is located over a riffle which has a high right bank and long, sloping point bar on the left bank. There has been an increase in the height of the point bar by 0.53 ft and corresponding aggradations of the streambed by 0.81 ft. While there have been some adjustments to the channel since construction, there has been little lateral movement and the channel is stable. The unusual elevations for post-construction station 0+03.3 and 2 year monitoring station 0+56 is attributed to incorrect rod readings due to the rod beacon having to be hand held on the rod. This can be the only explanation for these odd elevations since the bank profiles have not changed during the monitoring period.

CROSS-SECTION 17+08 – pool (Figure 3.8): This cross-section was added to monitor the pool formed by root wads used to stabilize the bank. At the time of the 2004 survey, this area was not experiencing any stability problems.

CROSS-SECTION 17+57 – riffle (Figure 3.9): This cross-section is located in a run/riffle complex below a rock weir. The tops of the banks show some ground settling has occurred since construction. There have been some minor adjustments to the bankfull and floodplain areas that have captured sediments during high water storm events. There has been a 0.56 ft aggradation of the channel thalweg between post-construction and year 1 monitoring. This change in thalweg elevations is a result of stream channel adjustments following construction. The thalwag had a minor adjustment of + 0.10 ft between year 1 and year 2 monitoring period.

CROSS-SECTION 18+42 – riffle (Figure 3.10): This cross-section monitors a stable riffle that was not impacted by construction other than some minor grading along the top of the right bank. This untouched riffle shows the same sediment build-up along the banks as other cross-sections. The thalwag deepened by 0.31 ft from the year 1 to year 2 monitoring survey, bringing it back in line with the post-construction thalweg depth. Monitoring of this site shows that the stream thalweg will increase or decrease in elevation from year to year based on the number and magnitude of bankfull or greater events.

CROSS-SECTION 20+80 – pool (Figure 3.11): This cross-section monitors a constructed pool stabilized with root wads below a rock weir. The right bank has aggraded slightly due to sediments being deposited in the bankfull and flood prone areas. The thalwag of the pool has aggraded, reducing the depth of the pool by 0.82 ft. It will be interesting to observe if this pool continues to fill or if it will scour out following the next bankfull event.

These 11 cross-sections indicate that there has been no noticeable lateral movement of the channel since construction was completed in September 2001. Most of the cross-sections exhibit some build up of the streambanks due to deposition of materials during storm events. These thalwag changes do not indicate an unstable channel, but a channel bed that is constantly changing due to storm events.

Pebble Count Monitoring

Bed material analysis was conducted in a riffle at cross-section 18+42 (Figure 4). Pavement analysis (100 sample count wetted perimeter) has changed very little from post-construction to 2004. The D_{50} observed in the pavement was 16 mm, 26 mm and 27 mm for post-construction year 1, and year 2 monitoring. Since the post-construction survey, the D_{50} has changed from medium gravel to coarse gravel. The D_{95} was 94 mm, 93 mm, and 98 mm for post-construction, year 1 and year 2 monitoring. The D_{95} has remained in the small cobble particle size range. The bed material has exhibited little change since completion of the project.

Vegetation monitoring

A total of 2,229 bare root trees and live stakes were planted in the 3.02 acre conservation easement area during 2001-2003. The site is divided into four areas with a total count of stems (trees and live stakes) being made in each area (Table 1). The May 2004 survey found 1,076 stems were present; a 48.3% (356.3 stems per acre) survival rate (Table 1). The density of stems exceeds the 320 stems/acre required for woody species planted at mitigation sites through year three (USACE 2003). It should be noted that vegetation counts are difficult due to the small size of many of the plantings and high forbs growth at the time of the stem counts. Of the 14 tree/shrub species planted, those having a greater than 50% survival rate included silky willow *Salix sericea* (100%), tag alder *Alnus serrulata* (100%), flowering dogwood *Cornus florida* (50.7%), sycamore *Platanus occidentalis* (65%) and black cherry *Prunus serotina* (65.6%) (Table 2). The 100% survival rate for tag alder and silky willow is attributed to the high rate of natural regeneration by these species.

Livestock Exclusion

The livestock exclusion plan includes five watering tanks, two livestock crossings and approximately 4,400 ft of fencing. Livestock no longer have access to the riparian area along the unnamed tributary and two small spring seeps located on the Bare property. The two livestock crossings were damaged during the September 29, 2002 and November 19, 2003 storm events. Both crossings were repaired after each storm event. A change of design was needed at the crossings so that flood water debris would not catch on the fencing crossing the stream. Debris buildup on the barbed wire caused fence posts to be pulled from their positions, resulting in the failure of the fencing across the creek. To address this problem a removable cable system was developed that could be strung across the stream only when cattle were rotated between pastures.

Conclusion

Monitoring data indicate that the stream channel has made minor adjustments in the longitudinal profile and cross-sections as a result of large storm events. The stream is stable. However, minor repairs during the fall of 2004 were required at cross-sections 2+90 and 6+29 and at the two livestock crossings. As the riparian vegetation improves, streambank stability should continue to improve due to the exclusion of livestock from the riparian zone. The monitoring survey will be conducted again during 2005.

References

Mickey, J. H. and S. Scott. 2002. As-built report for the Bare mitigation site, unnamed tributary to Peak Creek, Ashe County. North Carolina Wildlife Resources Commission, Raleigh.

Rosgen, D. L. 1996. Applied river morphology. Wildland Hydrology Books. Pagosa Springs, Colorado.

USACE (US Army Corps of Engineers), Wilmington District, U. S. Environmental Protection Agency, North Carolina Wildlife Resources Commission, and the North Carolina Division of Water Quality. 2003. "Stream Mitigation guidelines". Wilmington, North Carolina.

FIGURE 1. Bare stream mitigation site on an unnamed tributary to Peak Creek, New River drainage, Ashe County, North Carolina.

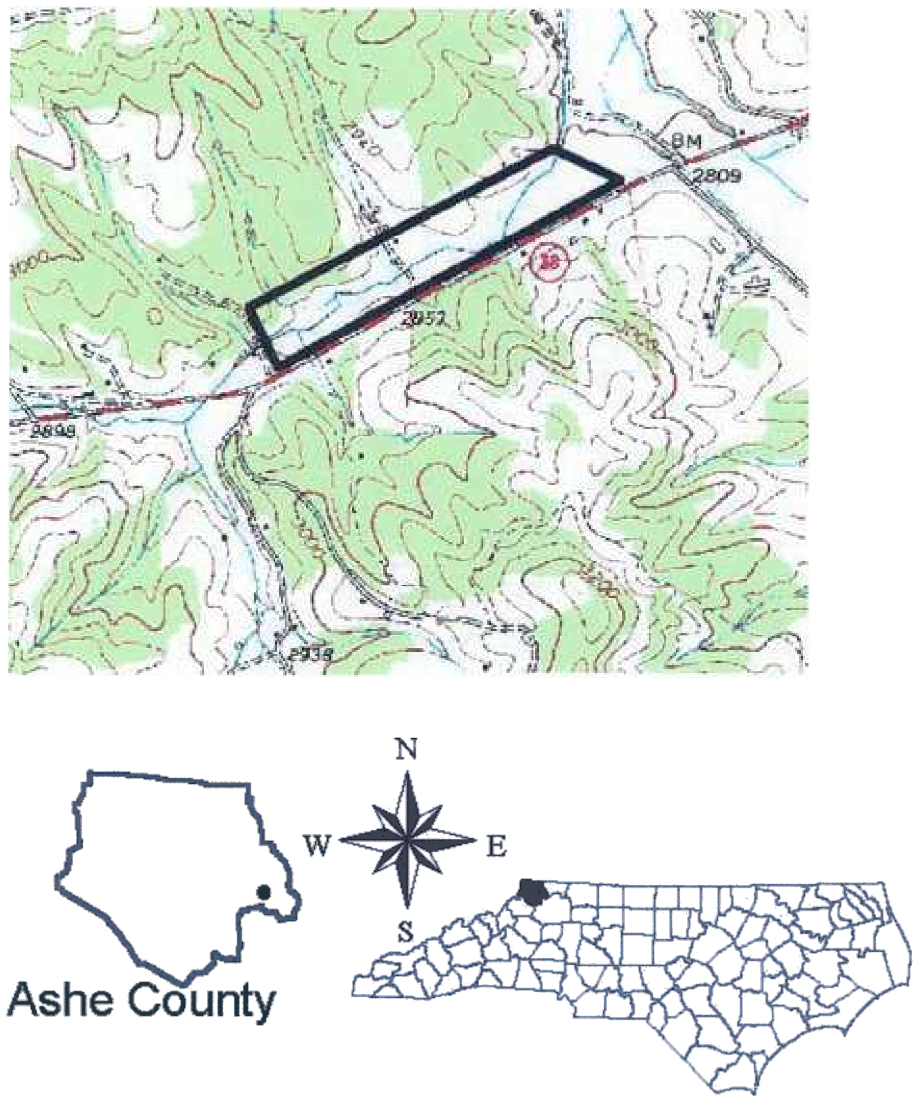


FIGURE 2. Longitudinal profile comparisons at the Bare mitigation site, UT to Peak Creek, Watauga County, 2001-2004.

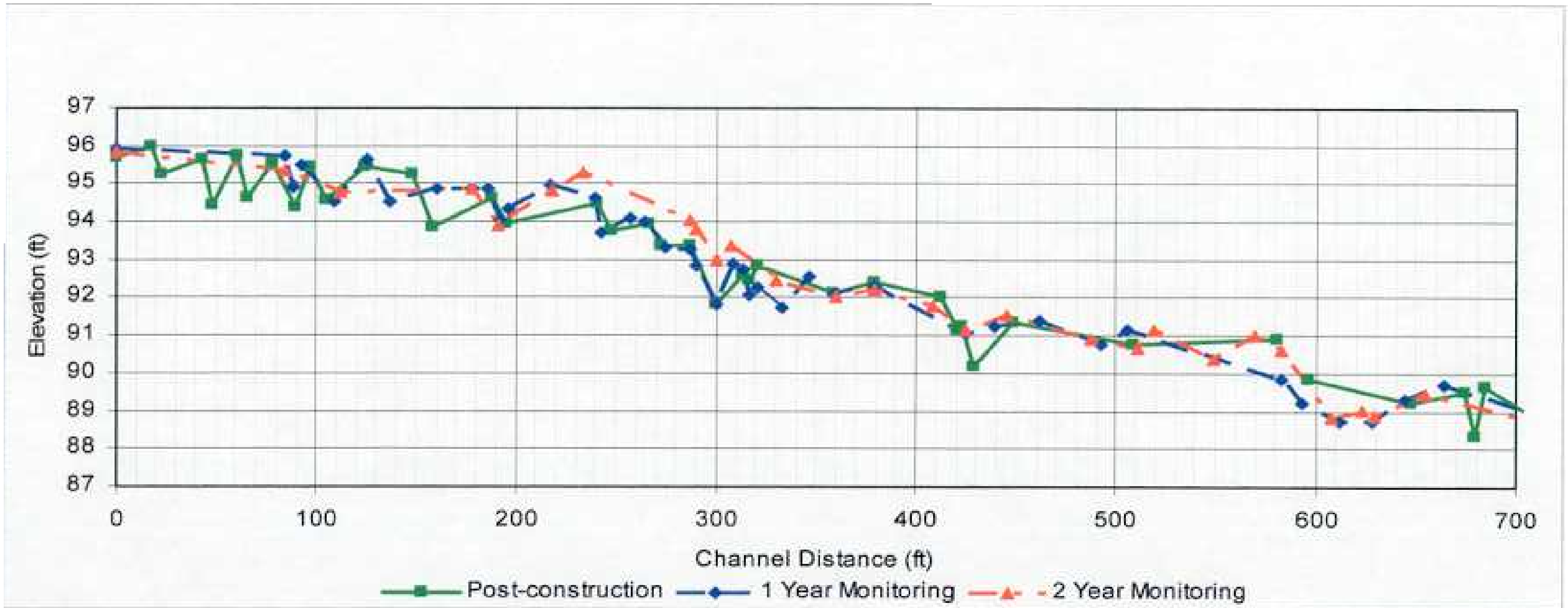


FIGURE 2.1. Longitudinal profile comparisons from station 0+00 – 7+00 feet.

FIGURE 2. Continued

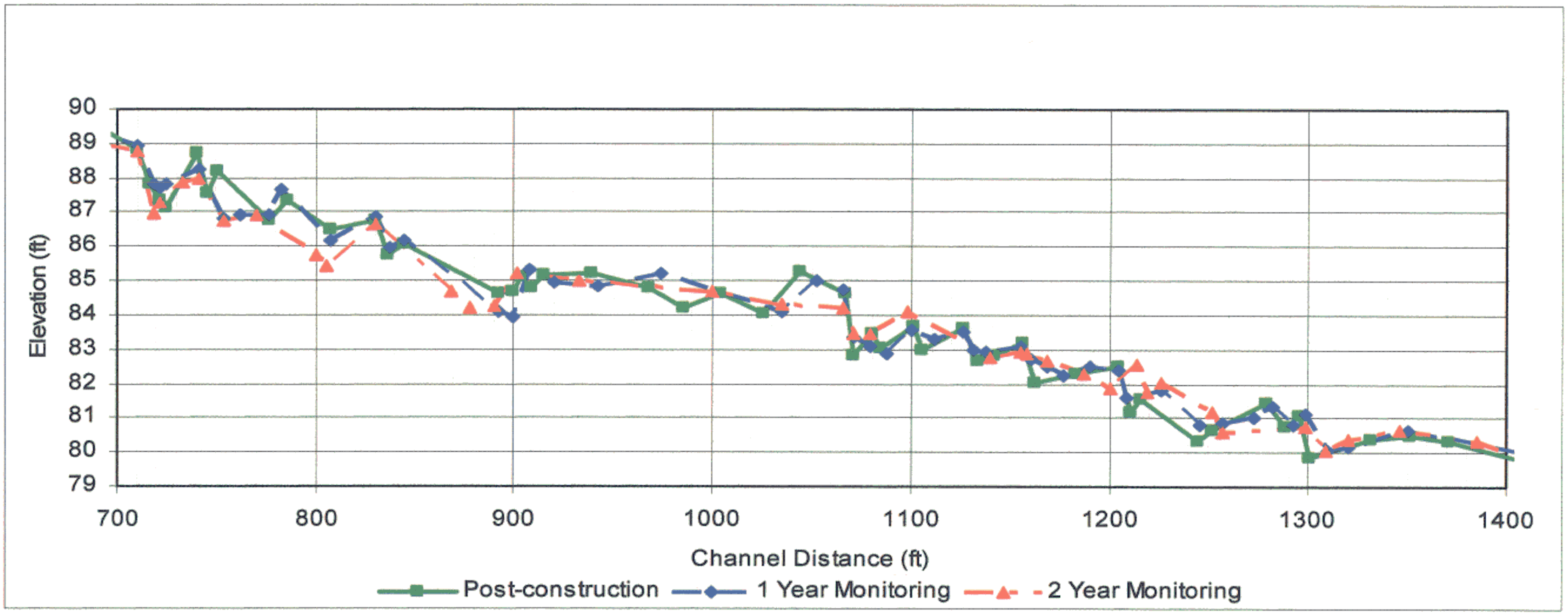


FIGURE 2.2. Longitudinal profile comparisons from station 7+00-14+00 feet.

FIGURE 3. Cross-section comparisons, Bare mitigation site, UT Peak Creek, Watauga County, 2001-2004.

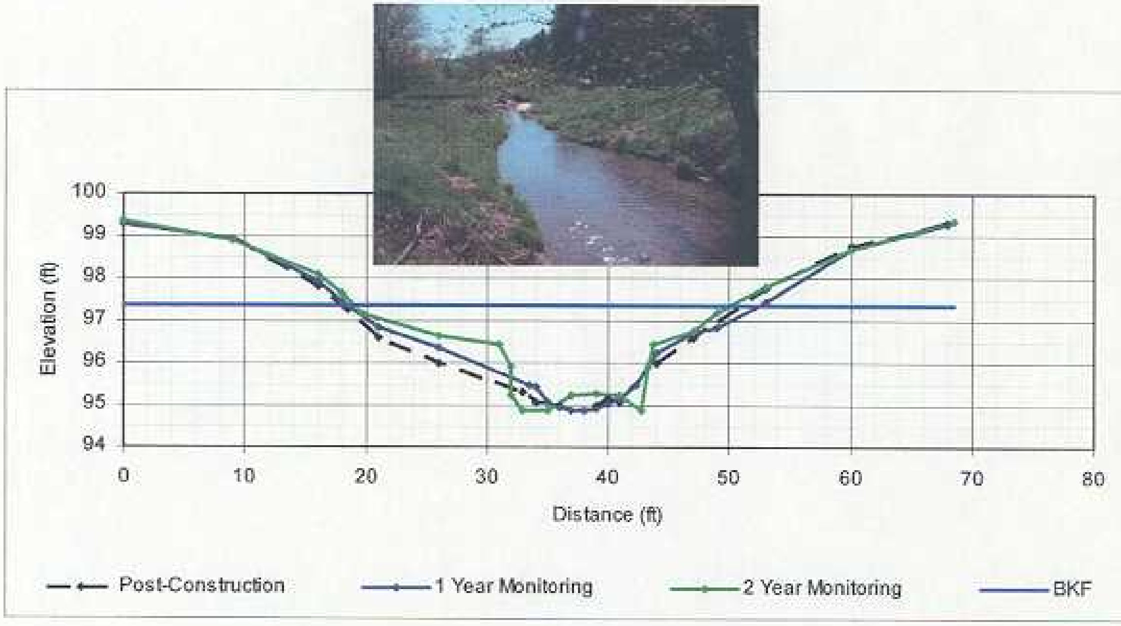


FIGURE 3.1. Cross-section station 1+78, pool.

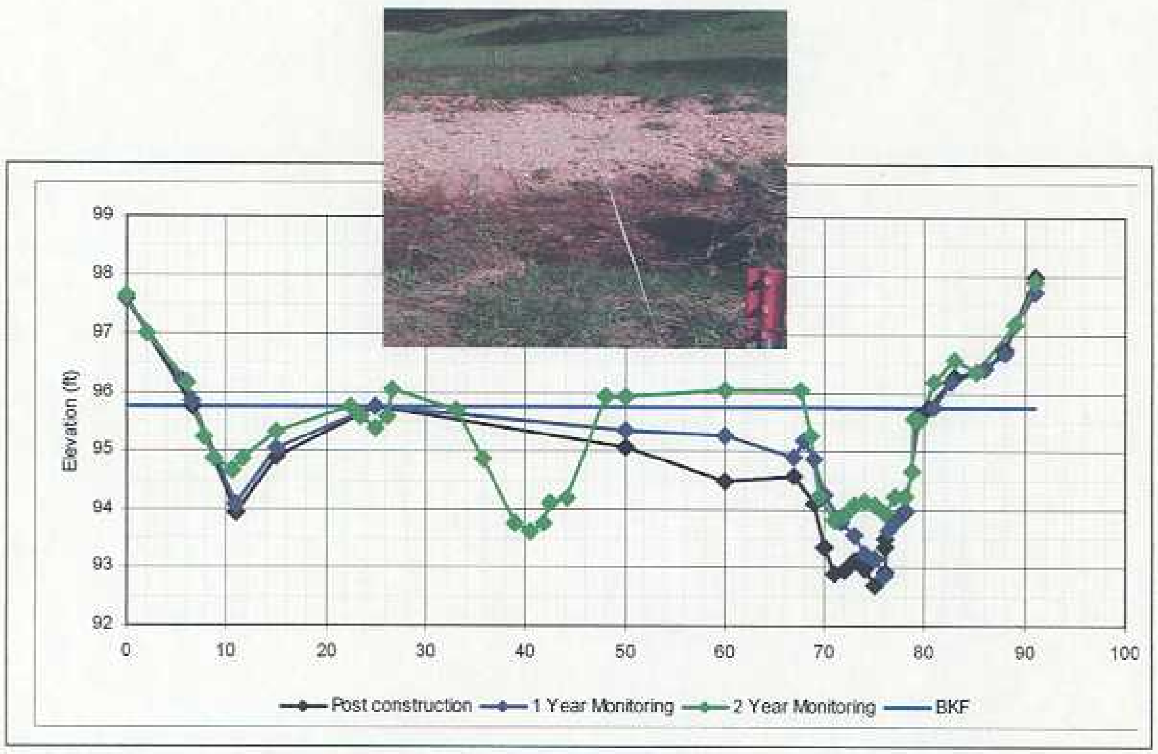


FIGURE 3.2. Cross-section station 2+90, riffle.

FIGURE 3. Continued.

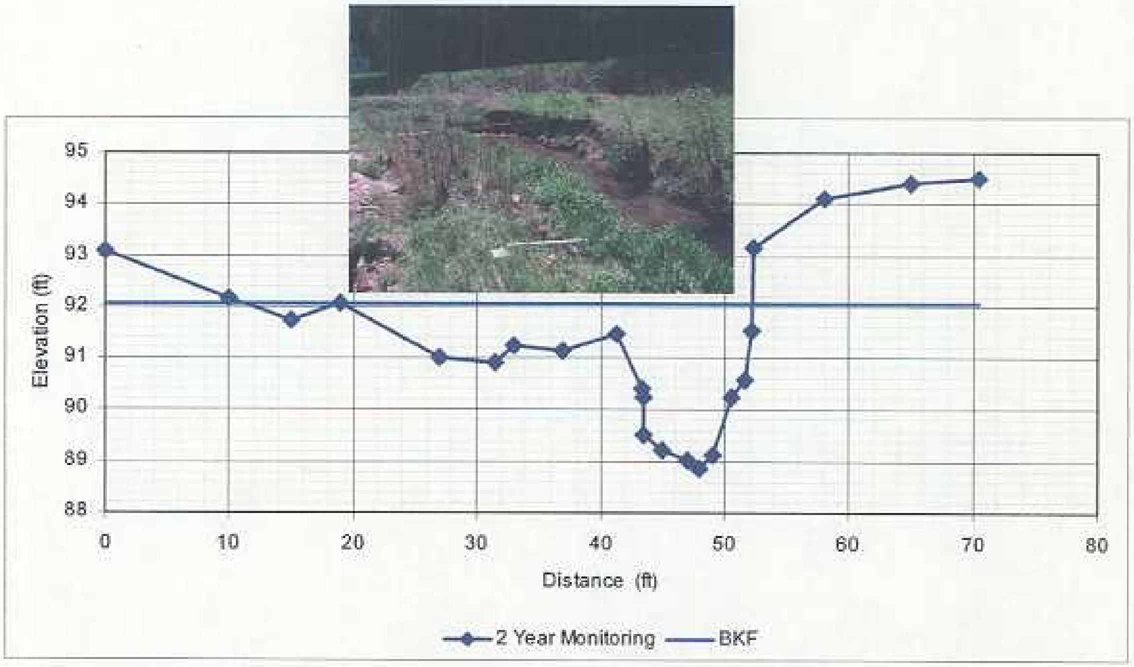


FIGURE 3.3 Cross–section station 6+29, pool, a new cross section in 2004.

FIGURE 3.4. Cross-section station 7+19, pool.

FIGURE 3. Continued.

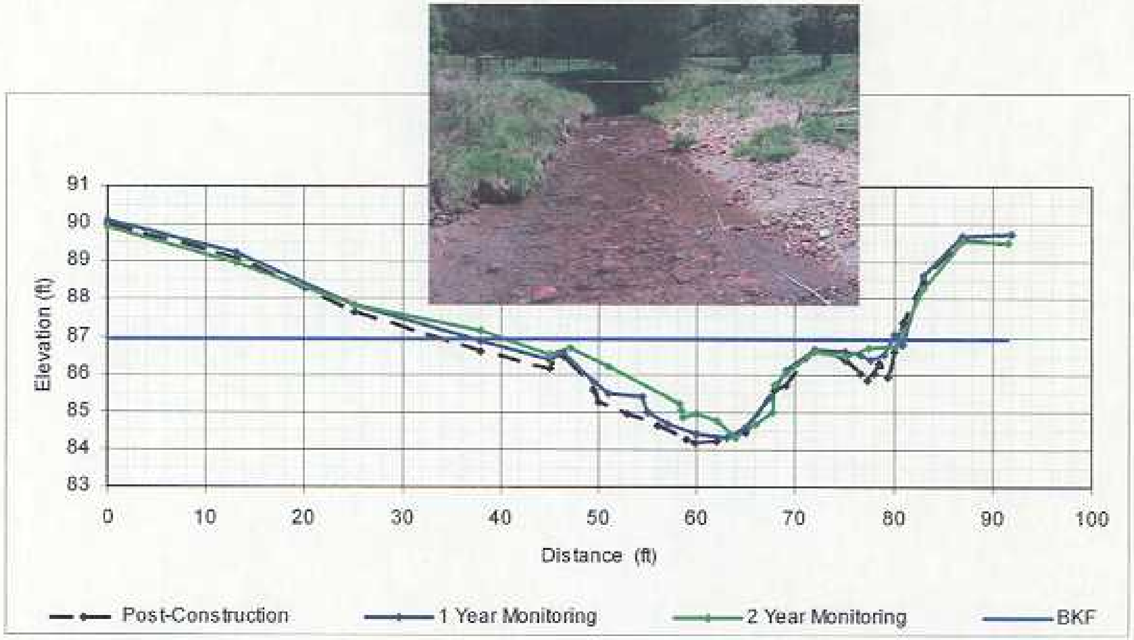


FIGURE 3.5. Cross-section station 10+35, riffle.

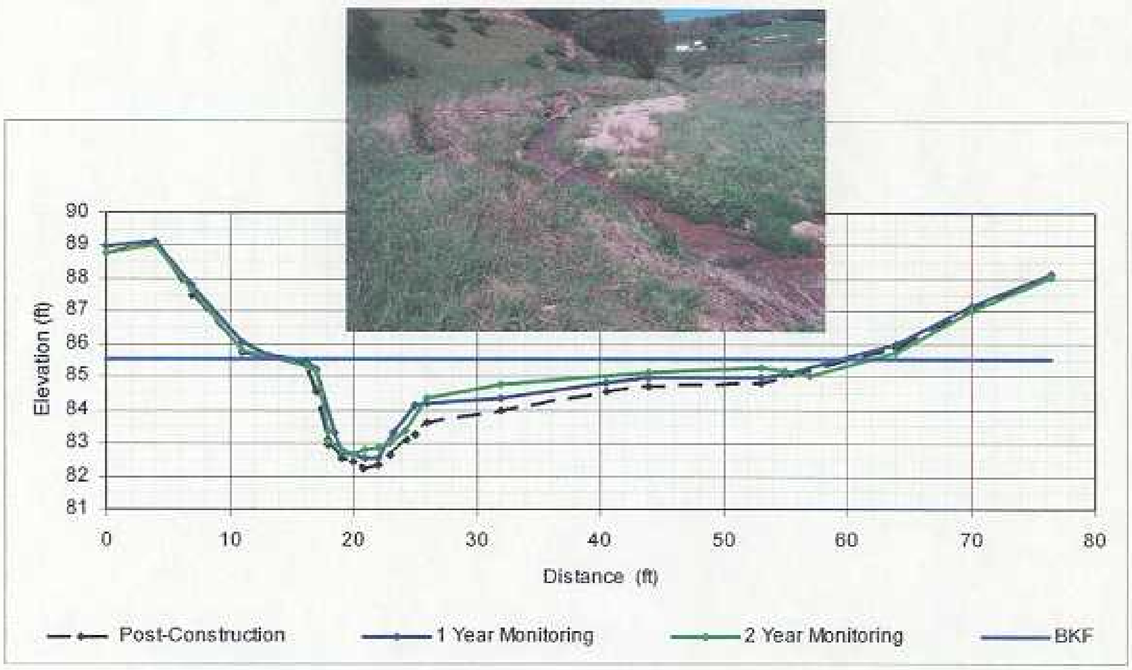


FIGURE 3.6. Cross-section station 11+68, riffle.

FIGURE 3. Continued.

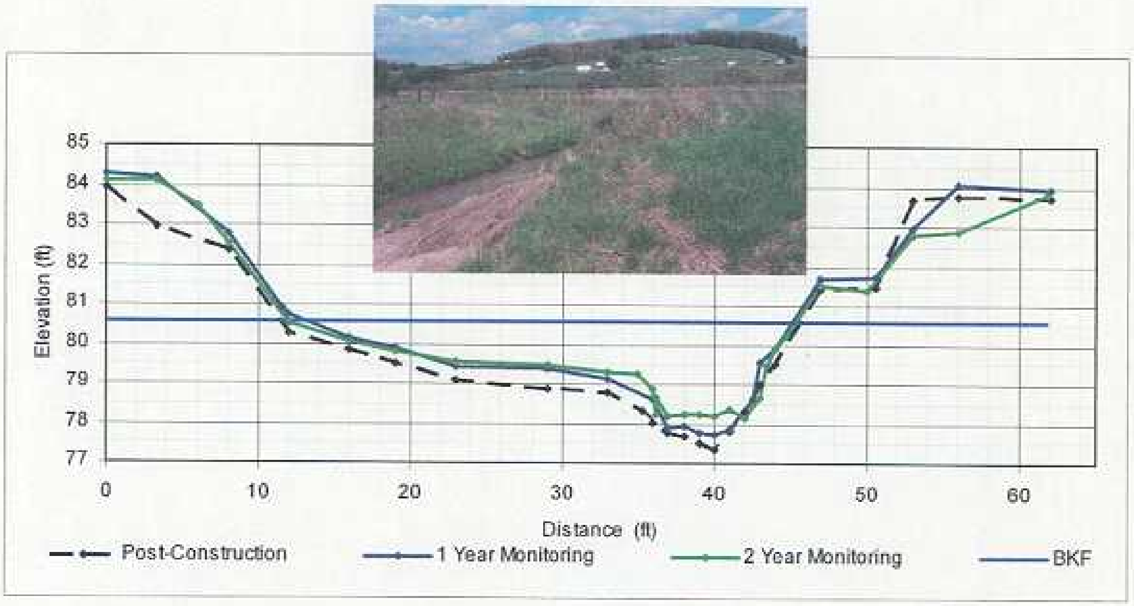


FIGURE 3.7. Cross-section station 16+81, riffle.

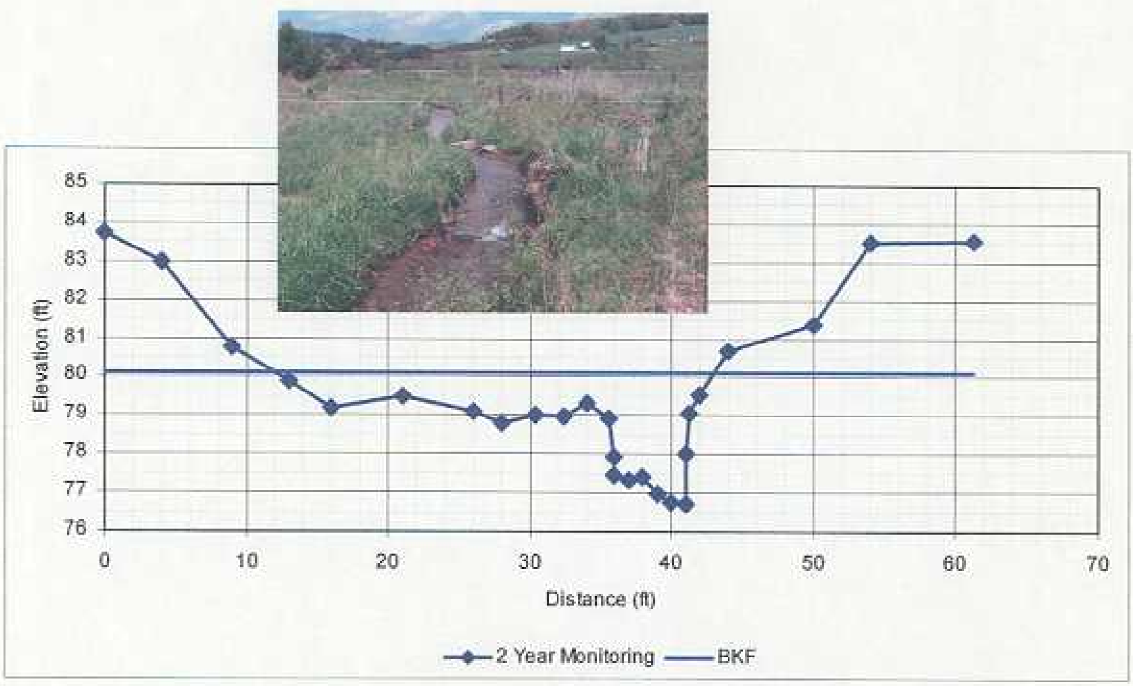


FIGURE 3.8. Cross-section station 17+08, pool, new cross section in 2004.

FIGURE 2. Continued

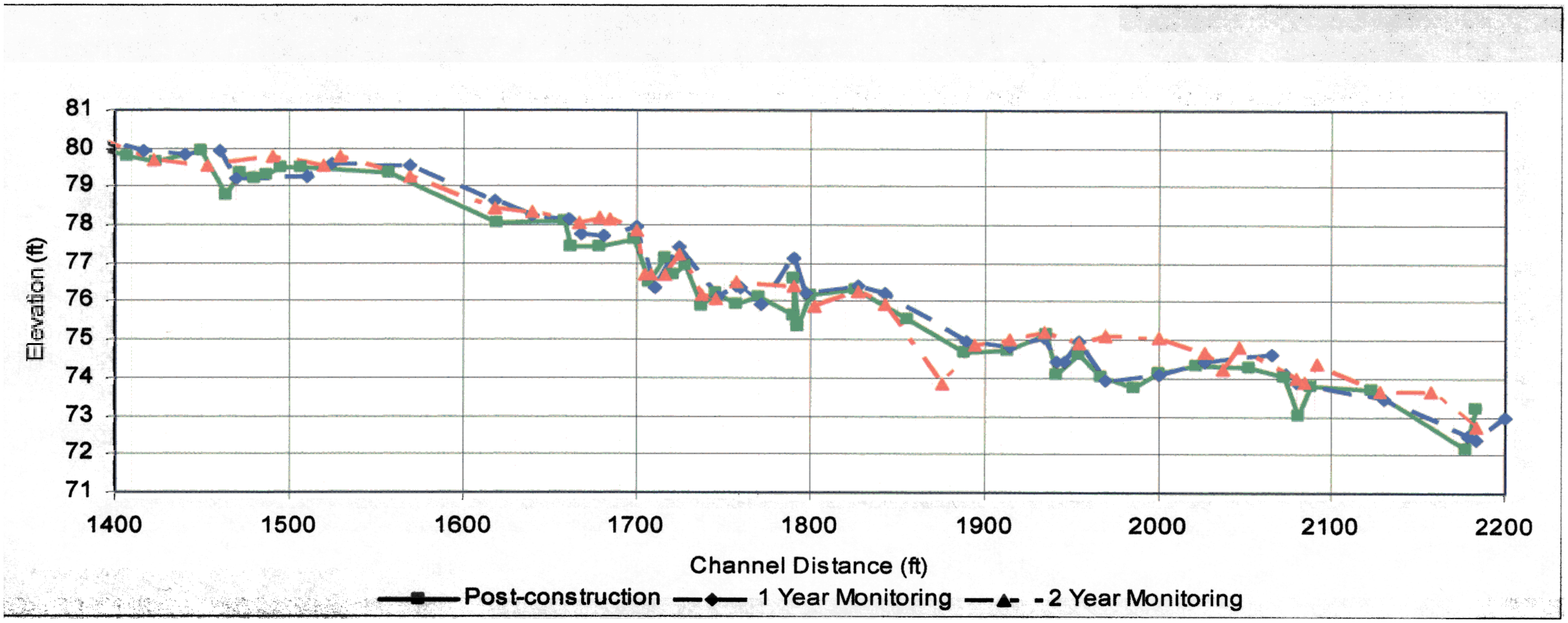


FIGURE 2.3. Longitudinal profile comparisons from station 14+00 – 22+00 feet.

FIGURE 3. Cross-section comparisons, Bare mitigation site, UT Peak Creek, Watauga County, 2001-2004.

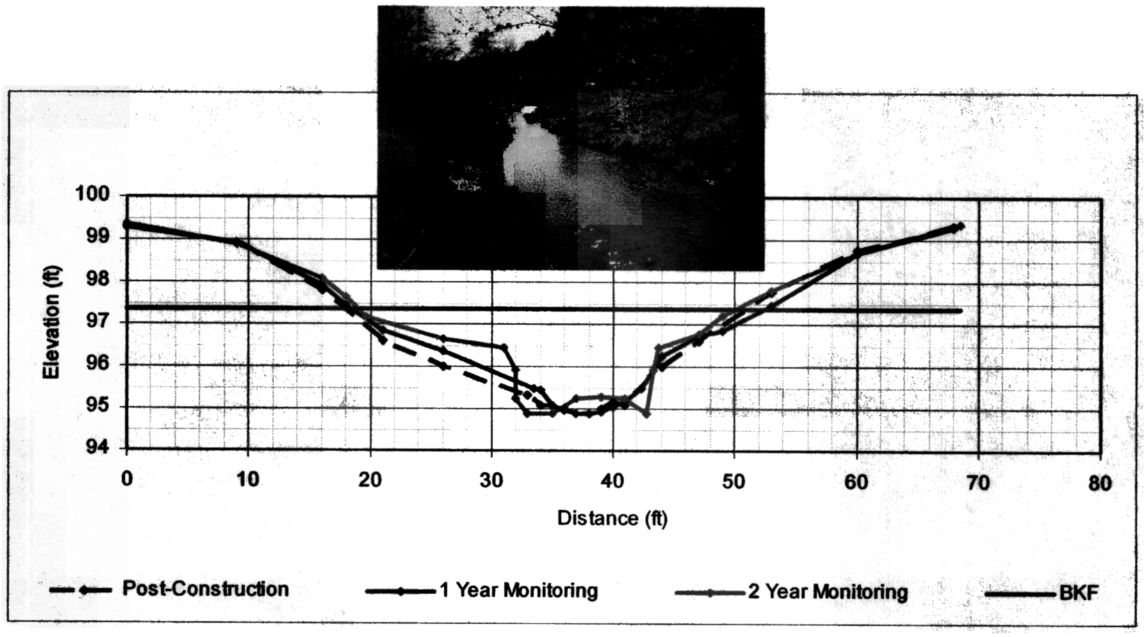


FIGURE 3.1. Cross-section station 1+78, pool.

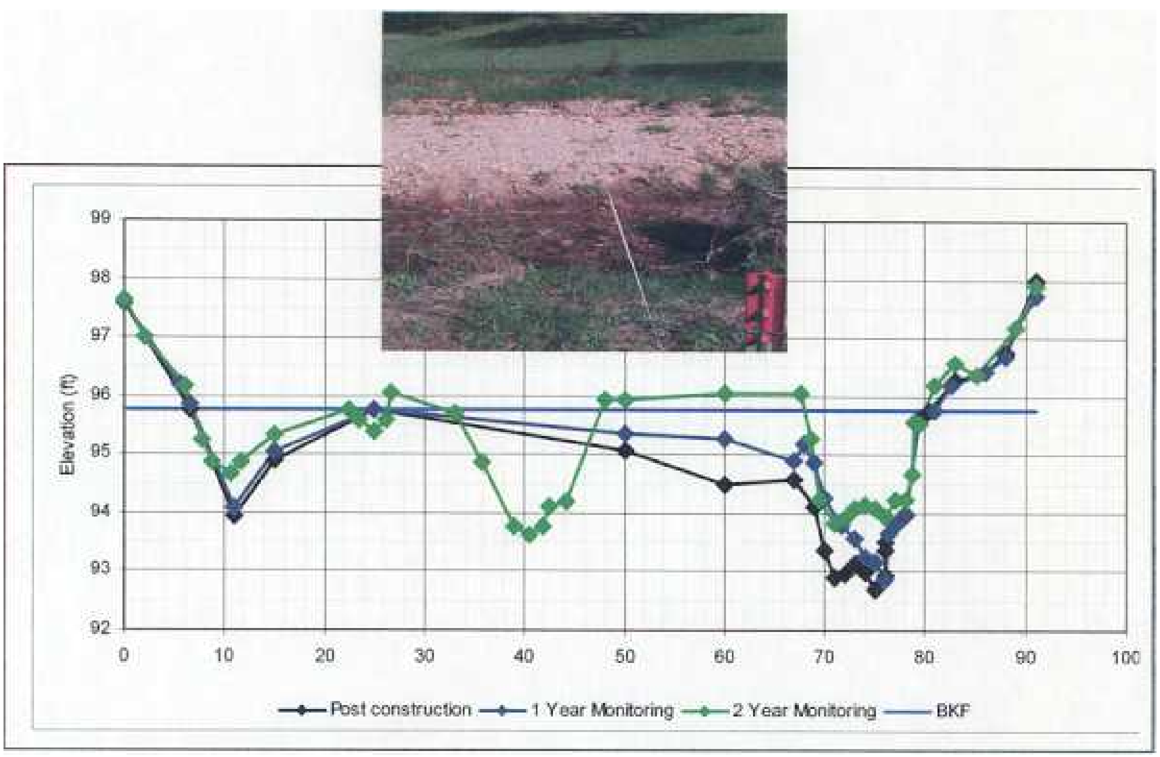


FIGURE 3.2. Cross-section station 2+90, riffle.

FIGURE 3. Continued.

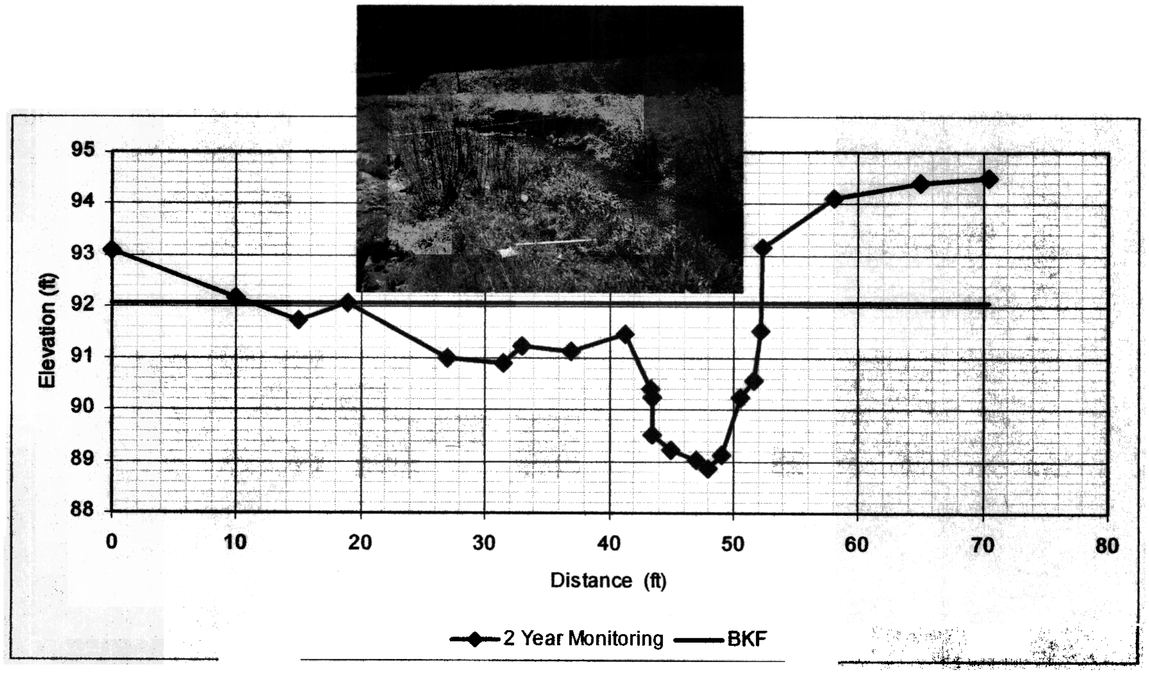


FIGURE 3.3 Cross–section station 6+29, pool, a new cross section in 2004.

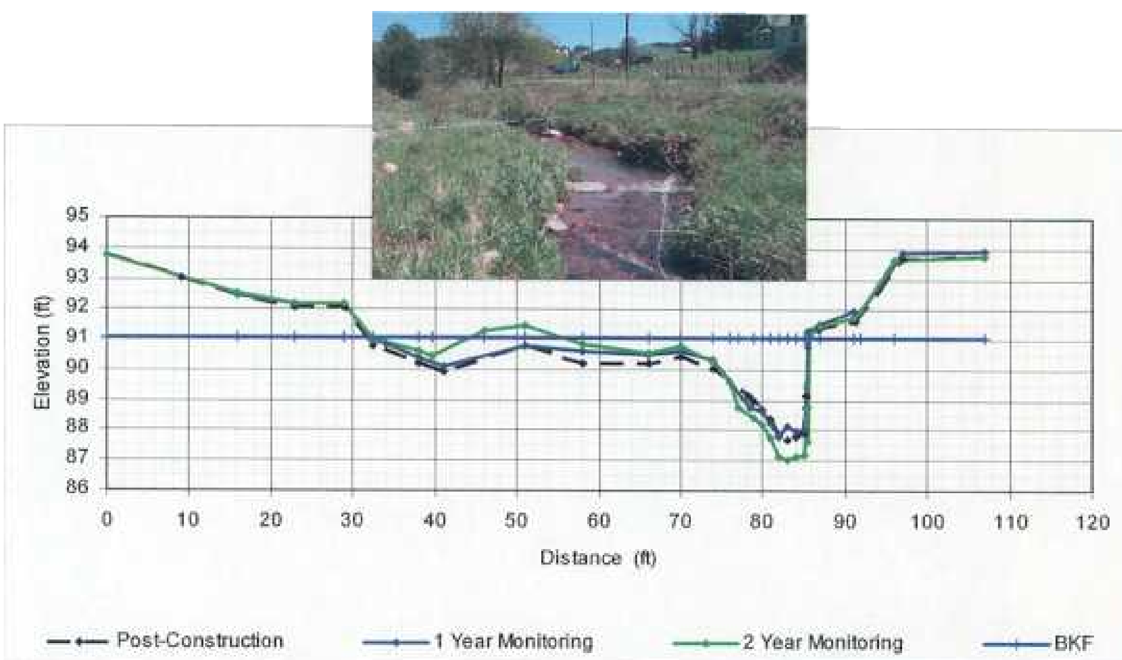


FIGURE 3.4. Cross-section station 7+19, pool.

FIGURE 3. Continued.

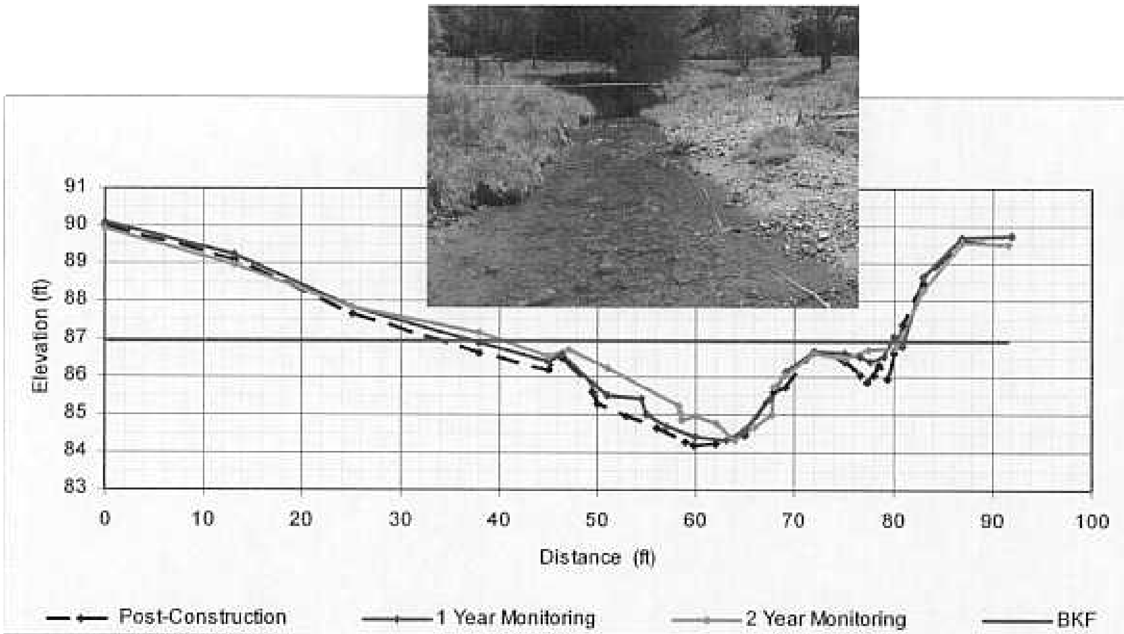


FIGURE 3.5. Cross-section station 10+35, riffle.

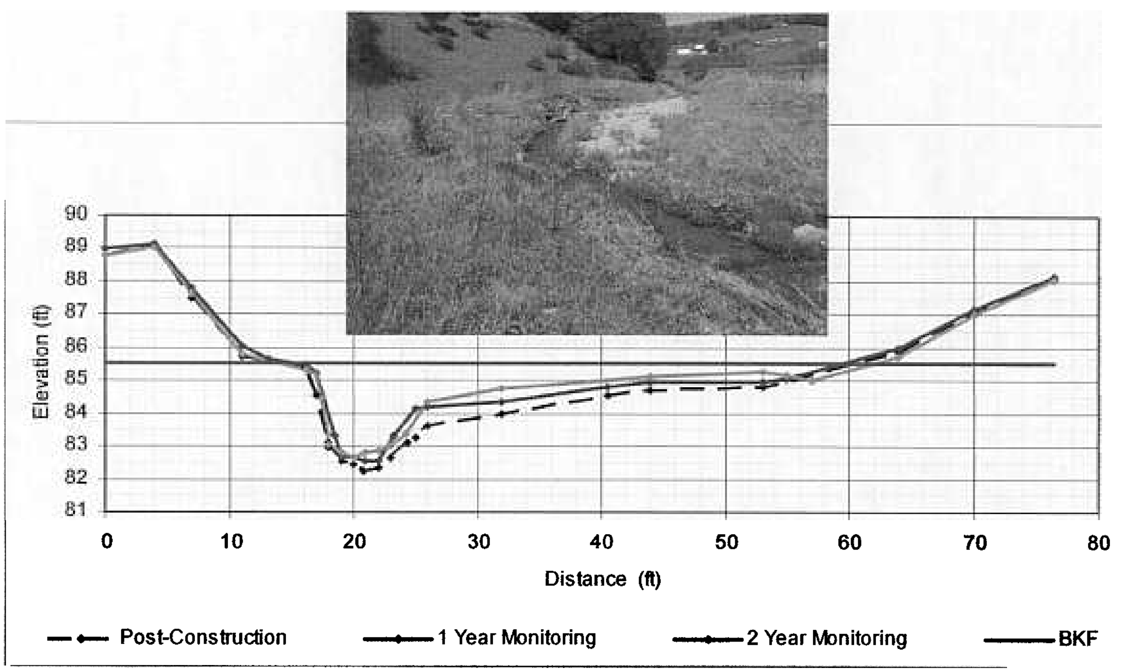


FIGURE 3.6. Cross-section station 11+68, riffle.

FIGURE 3. Continued.

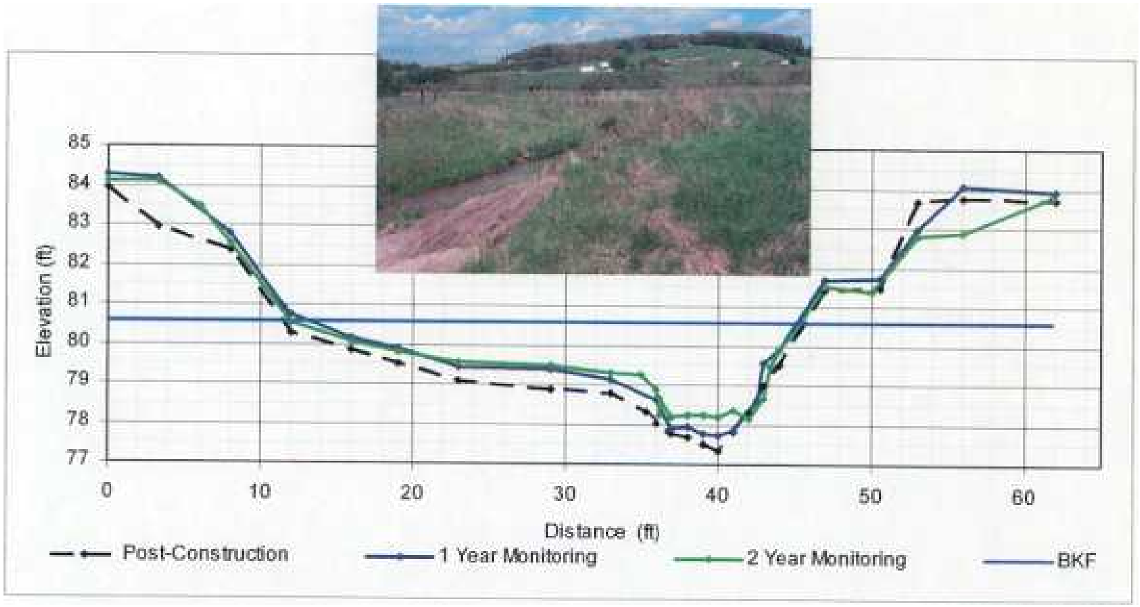


FIGURE 3.7. Cross-section station 16+81, riffle.

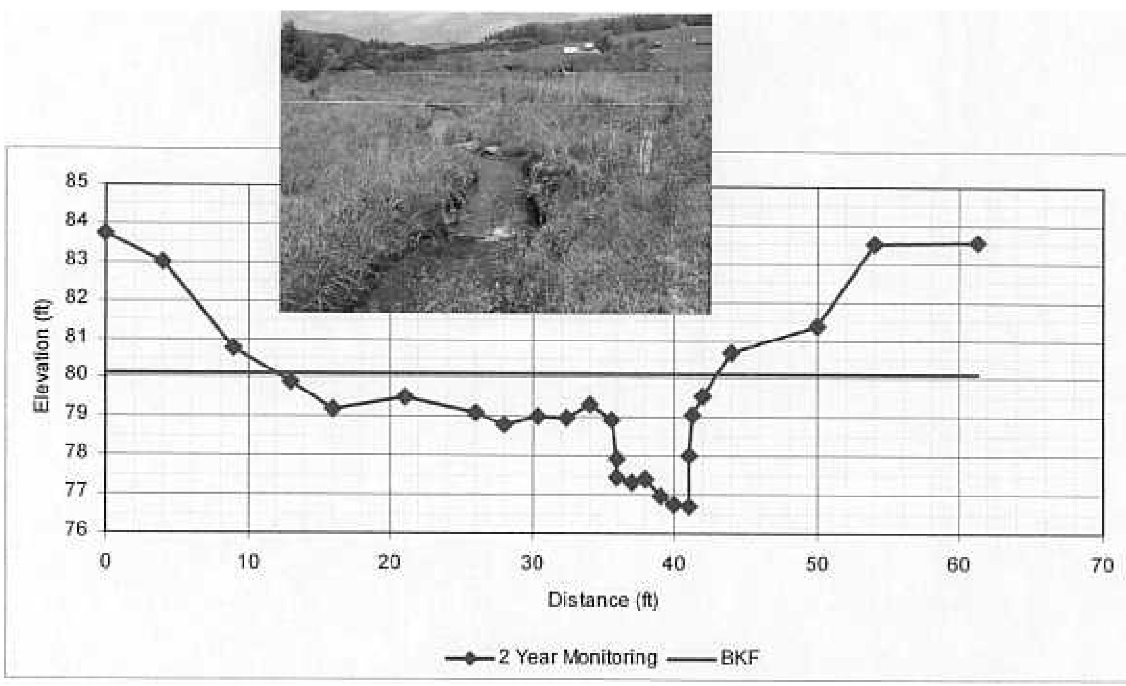


FIGURE 3.8. Cross-section station 17+08, pool, new cross section in 2004.

FIGURE 3. Continued.

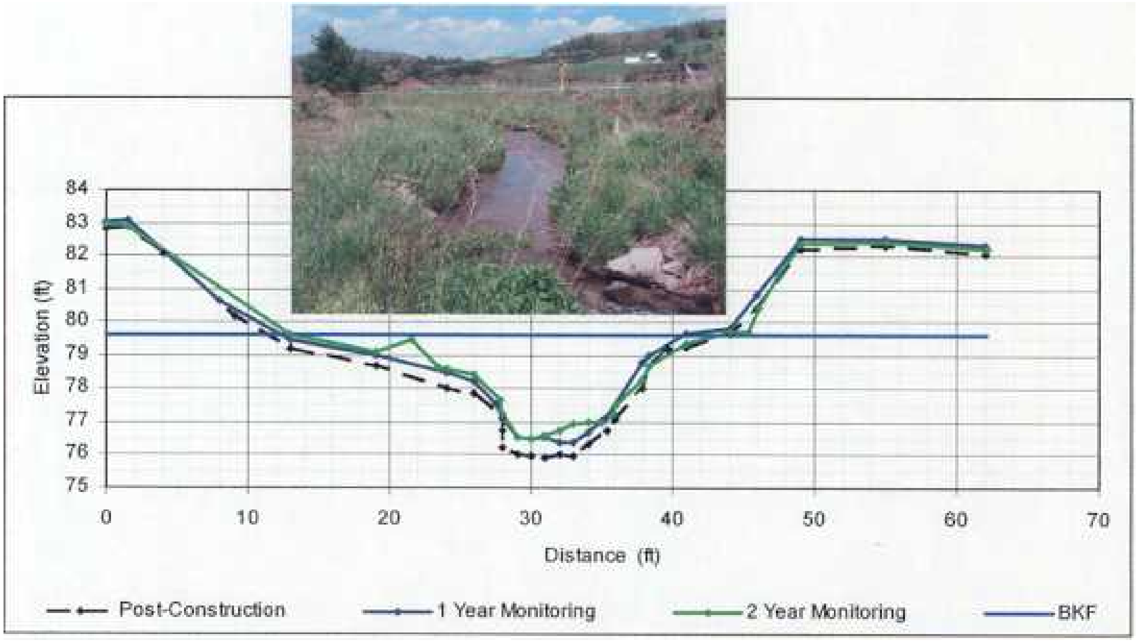


FIGURE 3.9. Cross-section station 17+57, riffle.

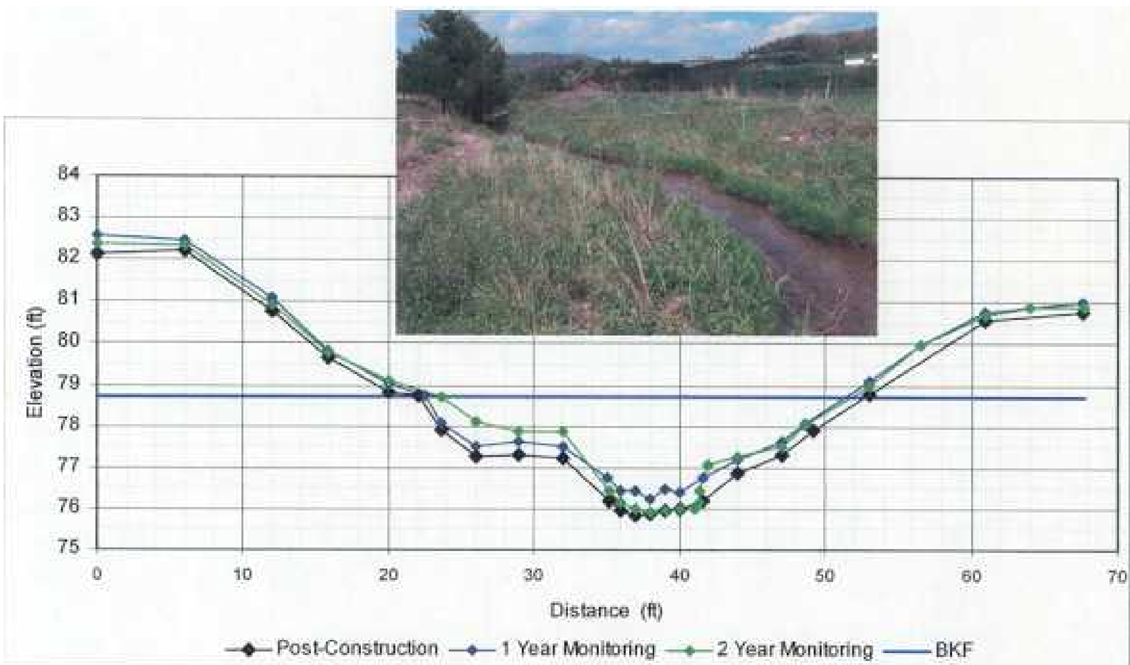


FIGURE 3.10. Cross-section station 18+42, riffle.

FIGURE 3. Continued.

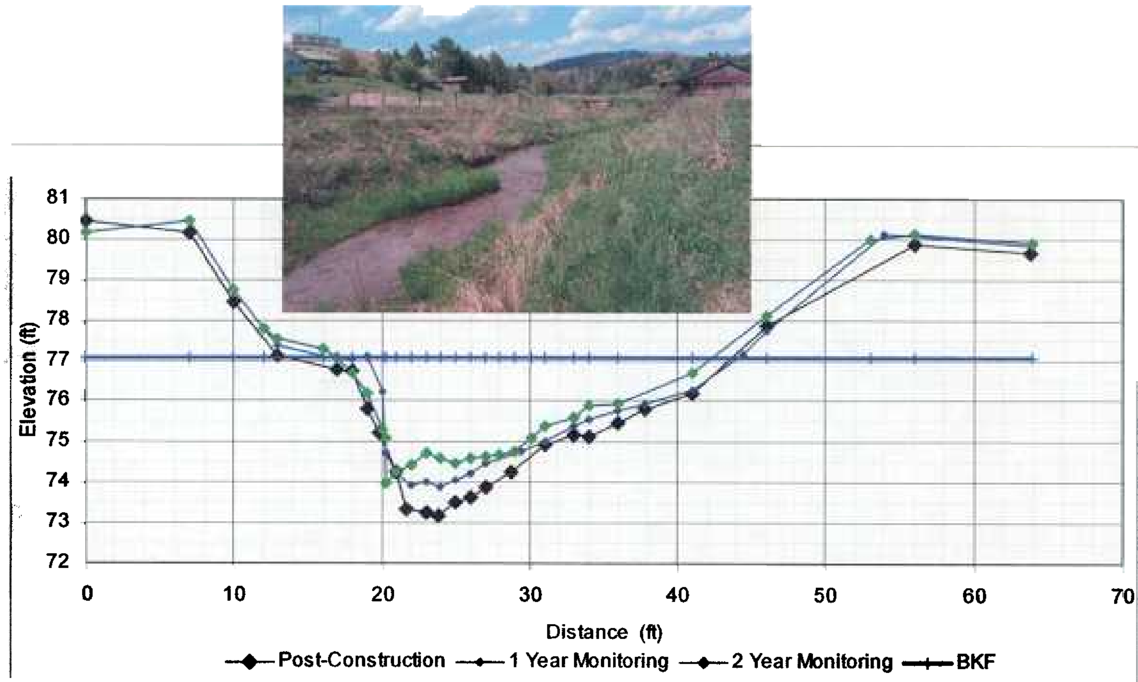
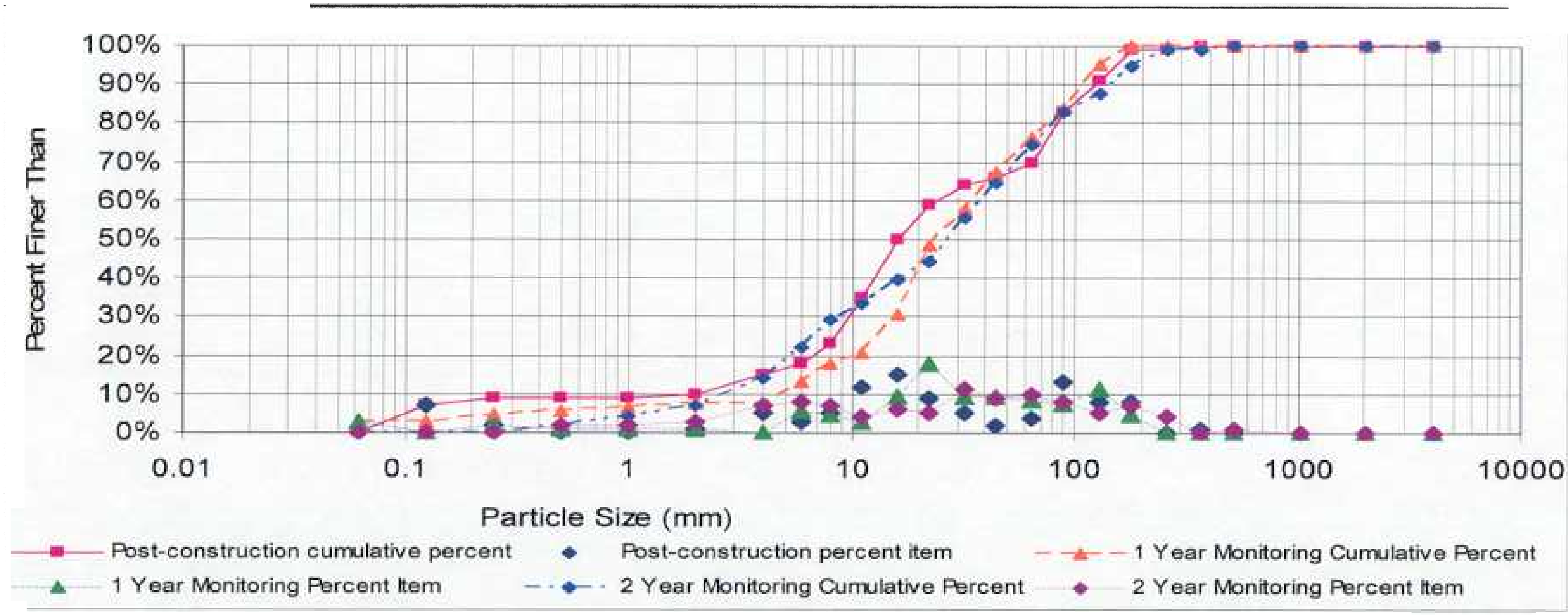


FIGURE 3.11. Cross-section station 20+80, pool.

FIGURE 4. Pebble count comparisons, Bare site, UT Peak Creek, Watauga County, 2001-2004



Size	Post-Construction Particle Size (mm)	1 Year Monitoring Particle Size (mm)	2 Year Monitoring Particle Size (mm)
D 16 (mm)	5	7	4
D 35 (mm)	11	17	12
D 50 (mm)	16	26	27
D 84 (mm)	94	93	98
D 95 (mm)	152	128	181

TABLE 1. Monitoring of inner berm and bankfull events at the Bare site based on data from the United States Geological Survey South Fork New River gage (no. 03161000) near Jefferson, Ashe County, North Carolina and from visual observations.

Date	Gage height (ft)	Flows (cfs)	Comments
February 27, 2002			Bankfull event (photo log)
February 22-23, 2003	5.0	2,250	Bankfull event
March 16, 2003	4.4	1,725	Inner berm event
April 10, 2003	5.4	2,819	Bankfull event
April 18, 2003	5.6	3,200	Bankfull event
June 7, 2003	4.1	1,820	Inner berm event
June 17, 2003	4.7	2,000	Bankfull event
August 9, 2003	4.2	1,450	Inner berm event
August 10, 2003	4.1	1,400	Inner berm event
August 19, 2003[1]	5.4	1,880	Bankfull event
February 7, 2004	4.8	2,080	Bankfull event

[1]This event produced major local flooding at the Bare, Carp, Racey and Miller sites, causing some damage to the Bare and Miller sites. According to eyewitness accounts, some local rains were in excess of 6 inches.

TABLE 2. Survival of live stakes and trees planted at the Bare mitigation site, unnamed tributary to Peak Creek, Ashe County, May 5, 2004

	No. planted	Survival Count, May 4 -5, 2004					
Type of plant	2001 – 2003	Area 1[a]	Area 2[b]	Area 3[c]	Area 4[d]	Total No.	%Survival
Live stakes							
Cornus amomum silky dogwood	700	64	92	40	21	217	31.0
Salix nigra black willow	76	0	0	5	1	6	7.9
Salix sericea silky willow	56	20	31	82	126	259[e]	100.0
Bare root nursery stock							
Alnus serrulata tag alder	45	60	135	40	40	275[f]	100.0
Betula nigra river birch	100	10	4	0	7	21	21.0
Celtis laevigata sugarberry	69	0	0	0	2	2	5.8
Cornus florida flowering dogwood	600	45	66	81	112	304	50.7
Diospyros virginiana persimmon	30	0	0	3	1	4	13.3
Fraxinus Americana white ashe	90	7	0	9	15	31	34.4
Juglans nigra black walnut	144	9	6	9	8	32	22.2
Platanus occidentalis sycamore	100	25	17	12	11	65	65.0
Prunus serotina black cherry	90	19	10	14	16	59	65.6
Quercus rubra red oak	112	0	4	9	5	18	16.1
Robinia pseudoacia locust	17	2	1	7	3	13	76.5
Total	2,229	211	246	281	338	1,076	48.3

[a]Area 1 from station 0+0 to station 5+59 at upper livestock crossing.
[b]Area 2 from station 5+69 at upper livestock crossing to station 10+46 at lower livestock crossing.
[c]Area 3 from station 10+64 at lower livestock crossing to cross-section 16+81.
[d]Area 4 from cross-section 16+81 to end of project at station 21+83.
[e]More silky willow counted than planted, unable to identify planted from natural regeneration. Also, some of the silky willow could have been black willow since it is difficult to tell the difference between young plants. We assume 100% survival of silky willow live stakes.
[f]275 alders were counted, unable to identify planted from natural regeneration alders. We assume 100% survival of planted alders.

Appendix 1. Photos of the Bare mitigation site on an unnamed tributary to Peak Creek, New River drainage, Ashe County North Carolina from December 2000 to May 2004.
KEY to terms: LDS – looking downstream; LUS – looking upstream; stn. – Station #; XS – cross-section.

LDS stn. 1+78 - 3+21 before work March 3, 2000

LDS stn. 1+78 - 3+21 after work & during flood September 27, 2002

LDS stn. 1+78 - 3+21 May 4, 2004

LDS XS 2+90 before work September 2000

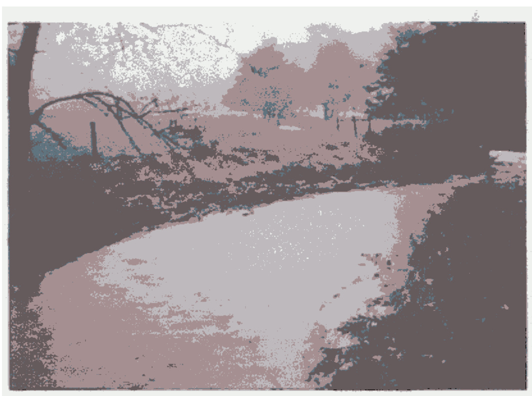
LDS XS 2+90 after work October 2001

LDS XS 2+90 during flood September 27, 2002

Appendix 1. Continued

LDS XS 2+90 after flood October 4, 2002

LUS stn. 5+50 eroding bank before work March 3, 2000



LUS stn. 5+50 after work & during flood September 27, 2002

Stn. 5+60 damaged crossing flood September 27, 2002

LDS XS 7+19 before work December 1, 2000

LDS XS 7+19 after work March 2002

Appendix 1. Continued

LDS XS 2+90 after flood October 4, 2002

LUS stn. 5+50 eroding bank before work March 3, 2000

LUS stn. 5+50 after work & during flood September 27, 2002

Stn. 5+60 damaged crossing flood September 27, 2002

LDS XS 7+19 before work December 1, 2000

LDS XS 7+19 after work March 2002

Appendix 1. Continued

LDS XS 7+19 during flood September 27, 2002

LDS XS 7+19 May 4, 2004

LUS stn. 8+90 before work March 3, 2000

LUS stn. 8+90 after work & during flood September 27, 2002

LUS stn. 8+90 after flood October 4, 2002

LUS stn. 8+90 May 4, 2004

Appendix 1. Continued

LUS XS 10+35 after fencing March 2002

LUS XS 10+35 notice channel narrowing October 4, 2002

LUS XS 10+35 May 4, 2004

Livestock crossing at stn. 10+54 after construction October 4, 2002

Livestock crossing stn. 10+54 after flood October 4.2002

LUS to stn. 10+54 during flood September 27, 2002

Appendix 1. Continued

LUS stn. 10+54 after flood October 4, 2002

LDS stn.10+79 before work March 3, 2000

LDS stn. 10+79 after work & during flood September 27, 2002

LDS stn. 10+79 after flood October 4, 2002

LDS stn. 10+79 May 4, 2004

LDS stn. 16+58 before work March 3, 2000

Appendix 1. Continued

LDS stn. 16+58 May 4, 2004

LUS stn. 18+26 before work September 7, 2001

LUS stn. 18+26 after work October 2001

LUS stn. 18+26 December 31, 2002

LUS stn. 18+26 during flood September 27, 2002

LUS stn. 18+26 May 4, 2004

Appendix 1. Continued

LDS stn. 20+47 after work & during flood September 27, 2002

LDS stn. 20+47 after flood October 4, 2002

LDS stn. 20+47 May 4, 2004

Livestock using water tank # 3 October 8, 2002

Livestock using water tank # 2 October 4, 2002